

# High bandwidth silicon photonic-crystal modulator based on vertical MOS capacitor

Xiaonan Chen<sup>1</sup>, Wei Jiang<sup>2</sup>, Jiaqi Chen<sup>1</sup>, Lanlan Gu<sup>1</sup> and Ray T. Chen<sup>1\*</sup>

<sup>1</sup>Microelectronic Research Center, Department of Electrical and Computer Engineering,  
The University of Texas at Austin, Austin, TX 78758, USA

<sup>2</sup>Omega Optics Inc, Austin, TX 78758, USA

\* Email: chen@ece.utexas.edu

## Abstract

We design and fabricate a vertical MOS capacitor-based silicon photonic-crystal modulator device and measure a 20-fF ultra-low gate capacitance that leads to a significant enhancement of the intrinsic modulation bandwidth.

## Summary

Recently Intel have experimentally demonstrated a 20-GHz silicon optical modulator based on free carrier plasma dispersion effect<sup>1</sup>. It has been suggested that the resistance capacitance (RC) limitations have to be taken into account to reduce the parasitic effects on the high frequency response of the active device. We design a vertical MOS capacitor-based modulator device and drastically shrink down the MOS gate area. Measurement shows the minimum gate capacitance is 20 fF with 5-volt driving voltage applied. Calculation indicates that the intrinsic modulation bandwidth limited by RC constant is improved to 80 GHz with 500-ohm contact resistance assumed. We embed the vertical MOS capacitor in silicon photonic crystal slabs to induce slow light effect near the band edge. The slotted photonic crystals also provide a convenient approach to generate necessary external electric field. The photonic crystal waveguides exhibit an extraordinary dispersion capability and therefore enhance the electro-optic effect greatly. Figure 1 shows the schematic cross section view of the vertical MOS-based photonic crystal modulator design.

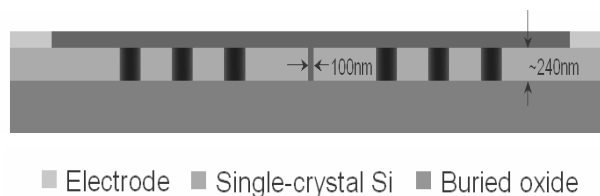


Fig. 1. Schematic cross section view of the vertical MOS based photonic crystal modulator design.

## Reference

<sup>1</sup>A. Liu, L. Liao, D. Rubin, H. Nguyen, B. Ciftcioglu, Y. Chetrit, N. Izhaky, and M. Paniccia, "High-speed optical modulation based on carrier depletion in a silicon waveguide," *Opt. Express* 15, 660-668 (2007).